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CEE 697z
*Organic Compounds in Water and
Wastewater*

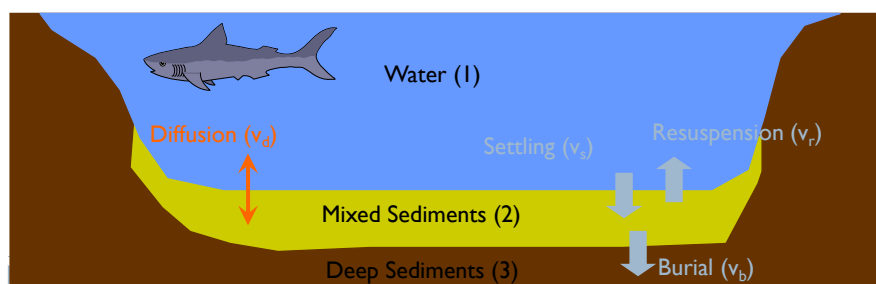
PCBs:
Introduction and Properties

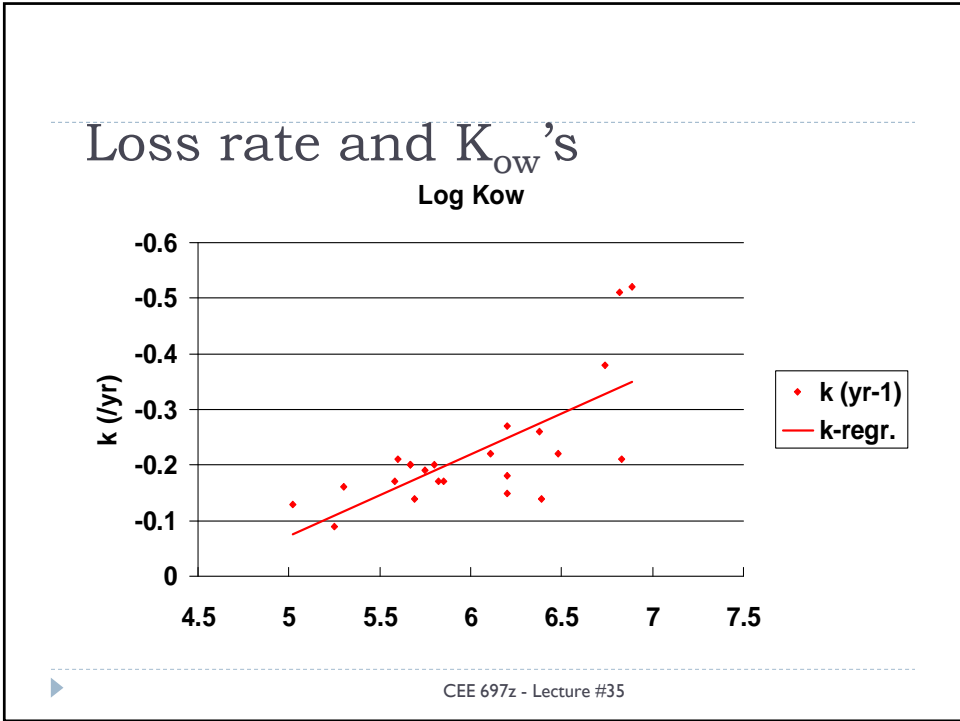
Lecture #35

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Toxics Model: CSTR with sediments

- ▶ Internal Transport Processes (between compartments)
 - ▶ dissolved: diffusion
 - ▶ particulate: settling, resuspension & burial
- ▶ Expressed as velocities (e.g., m/yr)





Areal Sediment Burden (mass)

- ▶ Estimated at 4900 kg in 1986
- ▶ using data from sediment cores
- ▶ relatively small compared to total lost from water column (26,500 kg from '80 to '92)

$$\sum PCB_{areal} = \sum PCB_i (1 - \phi_i) \rho_s z_i$$

PCB conc. (ng/g-dry sediment) in depth increment "i"

Porosity of increment "i"

Thickness of depth increment "i"

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Inputs

- ▶ Riverine
 - ▶ Known Q
 - ▶ Estimate c from analysis of pristine water
- ▶ Other
 - ▶ estimates from industrial, municipal, (urban) runoff and storm sewer flows gives a combined total of about 40 kg/yr

$$\begin{aligned}
 W &= Qc \\
 &= 5.4 \times 10^{13} \text{ L / yr} (2 \text{ ng / L}) \\
 &= 110 \text{ kg / yr}
 \end{aligned}$$

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Inputs (cont.)

▶ Direct Atmospheric deposition

- ▶ wet deposition

precipitation
Surface Area

$$\begin{aligned}
 F_{wet} &= \sum PCB_{T,rain} P(SA) \\
 &= 2 \text{ ng / L} (76 \text{ cm}) 8.21 \times 10^{10} \text{ m}^2 \\
 &= 125 \text{ kg / yr}
 \end{aligned}$$

- ▶ dry deposition
 - ▶ calculated for 4 seasons, then averaged

Dry particle deposition velocity (0.2 cm/s)

$$\begin{aligned}
 F_{dry} &= \sum PCB_{T,air} V_d \phi(SA) f_d \\
 &= 32 \text{ kg / yr}
 \end{aligned}$$

Fraction of year when it is not precipitating (0.9)

Fraction of PCBs associated with particles

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Outputs

- ▶ **Outflow**

- ▶ St. Mary's River

$$W_{outflow} = 7.1 \times 10^{13} \text{ L / yr} (0.84 \text{ ng / L}) = 60 \text{ kg / yr}$$

- ▶ **Burial (net loss to sedimentation)**

- ▶ estimated at 110 kg/yr from sediment cores collected in 1986 and 1990

- ▶ **Net Volatilization**

- ▶ true volatilization minus gas absorption
 - ▶ assumed to account for missing flux

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Reactions

- ▶ **NONE!**

- ▶ “evidence does not exist to support PCB degradation in Lake Superior or any other oligotrophic, aerobic system exhibiting low ambient concentrations”

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Congener-specific sedimentation

- ▶ Calculation of first-order net sedimentation rate

Mass sedimentation rate (mg/cm²/yr)

$$k_{sed} = \frac{\left[\frac{W_{sed}}{INV_w} \right] f_p}{RR}$$

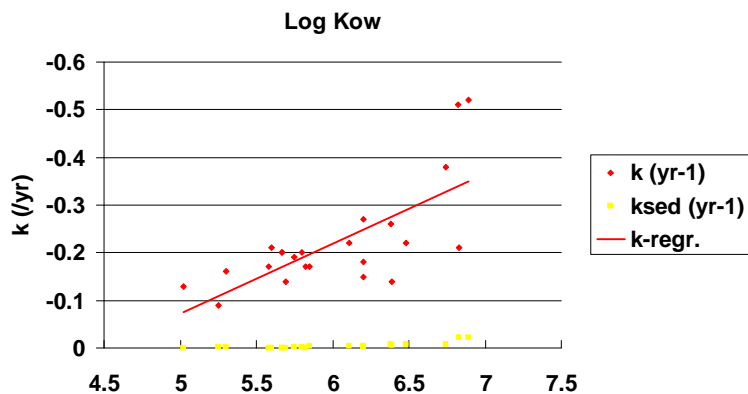
Inventory (or areal TSS)

Fraction particulate

Recycling ratio = downward flux (from sed trap) divided by the accumulation in the sediment

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Sedimentation vs overall loss rate



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